

Harmonic Compensation for Non Linear Load Using PWM Based Active Filter

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Abstract - In this paper the elimination of the current harmonics of injected by nonlinear loads is investigated. The active power filter proposed in this study is a Single phase voltage source inverter (VSI) connecting to the AC mains. The dspic controller is used to control the operation of the switches of the inverter. Active filtering is achieved through PWM inverter connected next to a given nonlinear load or at the point of the common coupling (PCC). The simulation results show that how well the filter eliminates the harmonics of the source current.

Index Terms-Active Filter, Inverter, Bridge rectifier, dspic30f2010, ZCD, Mosfet.

I. INTRODUCTION

In power systems due to increase of the usage of solid state devices. Power electronic devices generate harmonic and reactive current in the utility systems. The harmonic and reactive currents lead to low power factor, low efficiency and harmful disturbance. Harmonic distortion will create a serious problem in the neighborhood appliances, as well as heating of transformers .

A. Types of Filters

The passive L-C filters can be used to remove these problems but they have many disadvantages such as large size, resonance, fixed compensation, noise, etc. In passive filters, the problem is. absorbed filter current is not controllable so, it does not provide a complete solution. APFs can be connected to the circuit in series or parallel .Using active filter (APF) is an efficient solution for all these. The series APF is normally used to eliminate. voltage harmonics, spikes, sags, notches, etc.

While the parallel APF is used to eliminate current harmonics and reactive components. Power components. The converter used in APFs can be either a current source inverter (CSI) with inductive energy storage or a voltage source inverter (VSI) with capacitive storage . Some of single-phase loads, such as domestic lights, ovens, furnaces, TVs, computer power supplies, air conditioners, printers and adjustable speed drives behave as nonlinear loads. The load consists of an uncontrolled bridge rectifier and a parallel connected resistor. The proposed active power filter is a single-phase full-bridge inverter.

The input of APF is parallel with the load and its output. This model is well-known in UPS applications, in the presence of utility source voltage, the same inverter can be used

as an active power filter to eliminate the harmonics of non linear load.

The control of parallel APF is a challenging task, due to the sinusoidal current that has to be generated. In general, the APF control involves three stages: signal measurement and conditioning, harmonic detection, and control. A many of solutions have been developed for APF control. Most of this approach the have been applied to filter current, computer power supplies, air conditioners, printers and adjustable speed drives behave as nonlinear loads.

The used nonlinear load and parallel active power filter circuit configuration is shown in Figure 1. The load consists of an uncontrolled bridge rectifier and a parallel connected capacitor and resistor. The proposed active power filter is a single-phase full-bridge inverter.

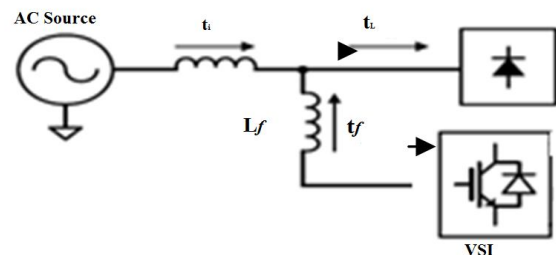


Figure 1 Principle configuration of a VSI based shunt APF.

II. WORKING PRINCIPLE

A shunt active power filter (APF) is a power electronic device used for mitigation of the harmonic currents from non-linear loads. It is connected either near to the non-linear load or at the point of common coupling (PCC) and it has the task to cancel out the harmonic content of the load current [1] (Fig. 2). As the cost of the APF is still relatively high, its utilization is more efficient for medium- or high-power applications. However, for high-power, the inverter cannot operate at very high switching frequency because of the considerable increase of the switching losses. On the other hand, a lower Switching frequency is not desirable because the reduced controller bandwidth determines improper harmonic compensation and unstable operation [4]. To meet the constraints of high-power, several solutions may be found for active filtering. One solution is to use hybrid power filters (HPFs), which requires a smaller rated inverter [3], but the HPF is not suitable in any case, for example when the reactive power needs also to be compensated.

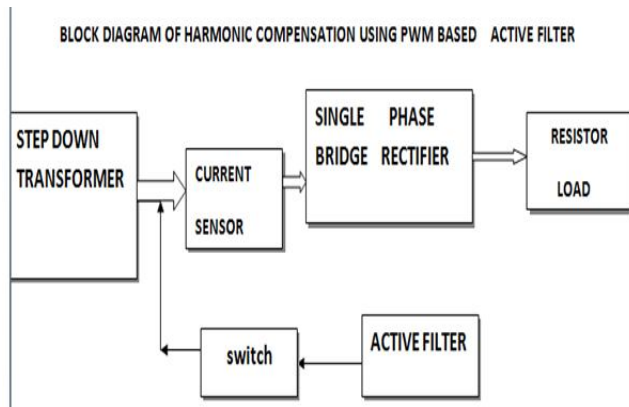


Fig.2. Block diagram of a shunt APF.

Solid state controllers are widely used to convert and control ac power to variety of loads to increase system efficiency and controllability. These converters draw non-sinusoidal current waveforms when supplied by a sinusoidal voltage source, generating harmonics, harmonic current propagation in electric power system results in distorted voltages and currents that can adversely affect the system performance in so many ways. Thus the project gives the design and implementation of a single-phase inverter used as Active filter which reduces the harmonic in current waveform and then this current is applied to non linear load .A bridge rectifier is non linear load. Reduction in harmonics is observed by analysing the current waveform using current sensor at the input of bridge rectifier when filter is connected and not connected .When the filter is not connected the content of harmonics is more which is visible at current sensor.

An inverter is a circuit which converts a DC power into an AC power, conversion can be achieved by MOSFET switches. The harmonics content can be minimized or reduced significantly by switching technique of high speed power semiconductor devices. The switching is done through control circuitry which applies dspic30F2010; switching instants are encoded in controller. A built in ZCD is used to detect zero crossing by controller. Inverter is connected at secondary of isolation transformer and primary is connected to secondary of step down transformer through a resistor. The gate driver circuit isolates the control circuit from power circuit using combination of opto coupler, transistor and buffer.

One potential solution that allows an increased switching frequency for high-power inverters is the use of proper pulse width modulation and comparing the switching losses. A similar algorithm based on instantaneous current values is proposed in for four-leg inverter, and applied for fundamental current. However, these applications are given for motor drives, where the output current is sinusoidal, with fundamental frequency. In APFs the inverter current mainly consists of harmonics, which makes the calculation of the phase angle or peak current difficult. Furthermore, the use of a fixed clamped region of 60, may not be very efficient for APFs, because of the complex shape of the inverter current, which has various peaks, depending on the existing harmonics.

The paper [7] describes a PWM strategy that detects the current vector position relative to the inverter voltage reference and instantaneously determines the optimum clamped duration on each phase. It achieves a clamped voltage pattern, with different durations depending on the inverter peak current at each instant. This adaptively clamps the switch that conducts the largest current at any instant, reducing the current stress and switching losses. This led to the thought that simply by controlling the switching instants through coding using PIC processor and was tried using the block diagram as in figure 2.

The proposed PWM is applied in this paper in active harmonic filtering, but it is proven that this modulator is suitable for any type of applications. The paper analyzes the PWM strategy, and describes its implementation has been a subject of intense research, different types of modulations being proposed for various applications. Selection of a proper modulator depends on the desired linearity, modulation range, waveform quality, switching losses, and easy of numerical implementation in digital signal processors (DSPs).

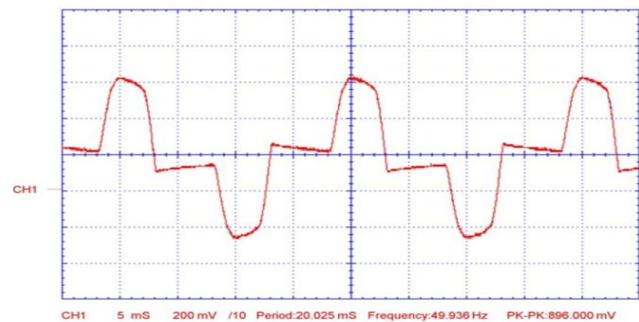


Figure 3(a) current waveform without filter

Current waveform with filter and without filter are shown in figure 3a & 3b. In figure a. The nature of waveform has more harmonics than figure b, which is done by controlling the switching instants, using MOSFET inverter with help of dsp30f2010 along with gate drive circuit. One of these benefits is the ease of use of the MOSFET devices in high frequency switching applications. The MOSFET transistors are simpler to drive because their control electrode is isolated from the current conducting silicon, therefore a continuous ON current is not required. Once the MOSFET transistors are turned-on, their drive current is practically zero. Also, the controlling charge and accordingly the storage time in the MOSFET transistors is greatly reduced

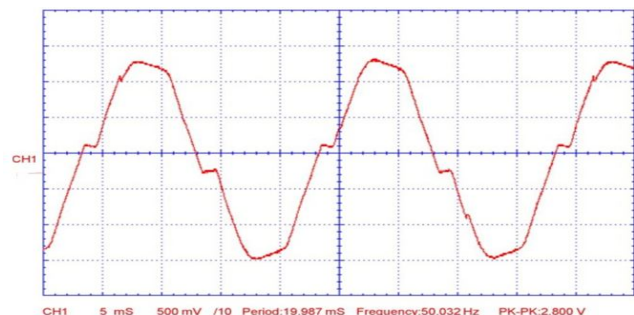


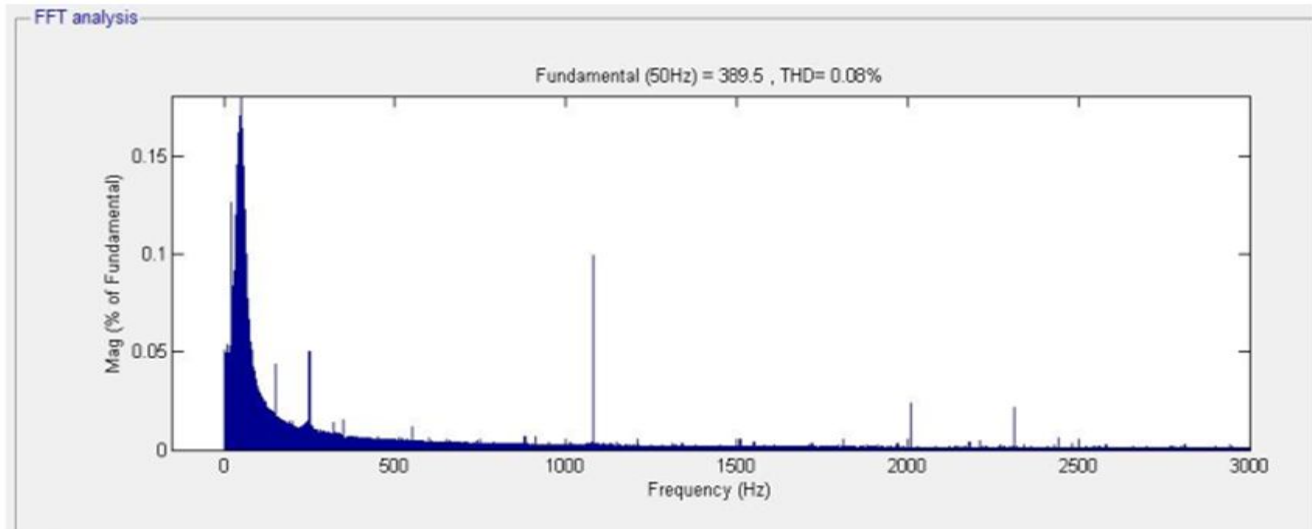
Figure 3(b) current waveform with filter

III. SIMULATION RESULTS

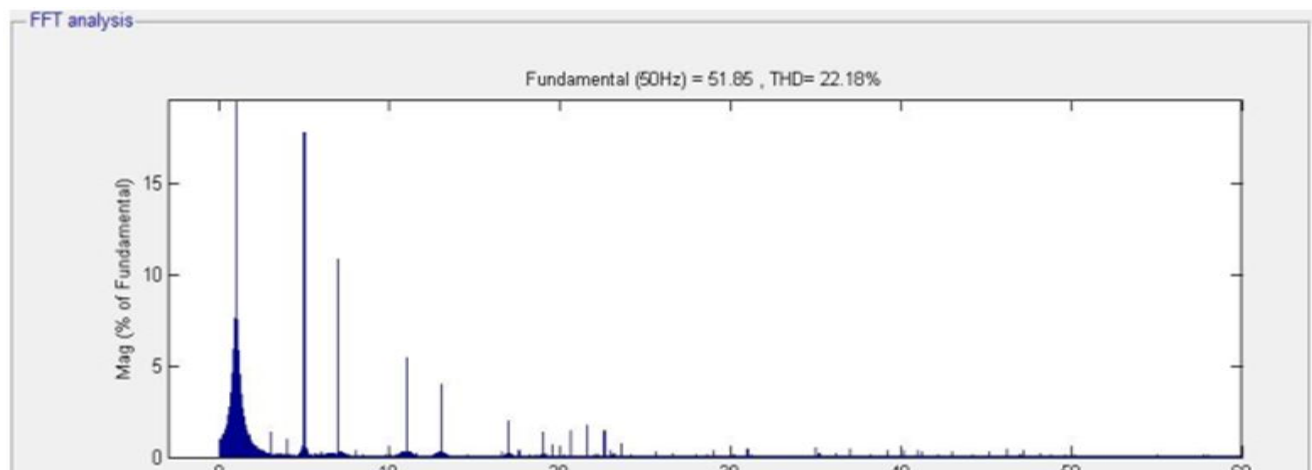
In the first step of simulation a non-linear load is connected to the 50Hz ac source, with no active filter across the load. The current, has a total harmonic distortion (THD) of 22.18% and an rms value of 19.56A. In the next step simulation of the module with active filter connected will have reduced total harmonic distortion value of 0.08 % as indicated in the figures below.

REFERENCES

- [1] Geeta M K , Prof .Mahadevi Biradar Push Pull dc - dc converter ,Global school of management, 3 march 2012
- [2] Kemal Kestane Ýres Ýskender A Simple Harmonic Compensation Method For Nonlinear Loads Using Hysteresis Control Technique 1694 Ieee Transactions On Power Electronics, Vol. 23, No. 4, July 2008



THD with filter



THD without filter

IV. CONCLUSION

An internal model based controller for shunt active filters has been proposed. This solution provides asymptotic cancellation of the current harmonics explicitly considered in the controller internal model. Experimental results enlighten the promising performances of the presented solution. In future works particular attention will be devoted to some issues not completely addressed in this paper, such as a deeper coordination between the current and voltage controllers, the evaluation/ compensation of the time delay effects for the generating nearly pure sinusoidal and a merge between the partial and selective compensation approach proposed in and the control technique proposed in this paper

- [3] S. Park, J.-H. Sung, and K. Nam, "A new parallel hybrid filter configuration minimizing active filter size," in Proc. PESC'99, 1999, vol. 1, pp. 400–405.
- [4] Cristian Lascu , Lucian Asiminoaei ,Student Member, IEEE, Ion Boldea , Fellow, IEEE, Frede Blaabjerg , Fellow, IEEE A Simple Harmonic Compensation Method For Nonlinear Loads Using Hysteresis Control Technique
- [5] Akagi H. "Trends in Active Power Line Conditions" IEEE Transaction on Power Electronics, vol. 9, No. 3, May 1994. pp.263-268
- [6] El-Harouk M., Darwish M.K., Mehta P., "Active Power Filters: A review" IEE Proc. Electr. Power APPL. 147, No. 5, September 2000

- [7] Lucian Asiminoaei, Member, IEEE, Pedro Rodríguez, Member, IEEE, and Frede Blaabjerg, Fellow, IEEE Application of Discontinuous PWM Modulation in Active Power Filters Ieee Transactions On Power Electronics, Vol. 23, No. 4, July 2008
- [8] Proceedings of the World Congress on Engineering and Computer Science 2010 Vol II WCECS 2010, October 20-22, 2010, San Francisco, USA Modelling and Simulation of Active Power Filters for Harmonic Compensation, Voltage Sags and Swells Mitigation and Power Factor Correction Michael C. Pacis, Jesus M. Martinez Jr., and Jaypee V. Tecson
- [9] B. Han*, *Senior Member, IEEE* Single-Phase Active Power Filter using FFT with Harmonic Phase-Delay Compensation
- [10] D C Bhonsle and N K Zaveri Department of Electrical Engineering C K Pithawalla College of Engineering and Technology Near Malvan Mandir, Magdalla Port, Dumas Road Surat, Gujarat, INDIA Dr R B Kelkar Department of Electrical Engineering Maharaja Sayajirao University Baroda, Gujarat, INDIA Design and Simulation of Single Phase Shunt Active Power Filter for Harmonic Mitigation in Distribution System